

Using *Mplus* to fit and test measurement and structural equation models

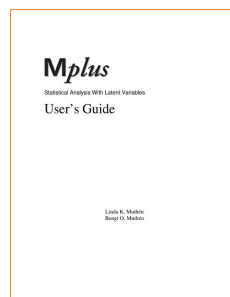
Video 1

Introduction to observed and latent variable models

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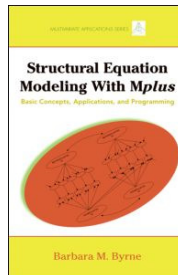
References and Sources

Mplus User's Guide – available for free download from
statmodel.com



References and Sources

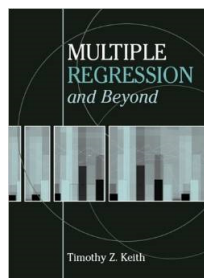
Byrne, Barbara M. (2012). Structural equation modelling with *Mplus*



(the datasets used by Byrne are available at <http://www.psypress.com/books/details/9781848728394/datasets/>)

References and Sources

Keith, Timothy Z. (2006). Multiple regression and beyond



Outline

- Multiple regression model
- Path model
- Factor model
- Full structural equation model
- What is meant by model fit
- Covariance structure and mean structure

Multiple regression 1

Byrne's model of teacher burnout

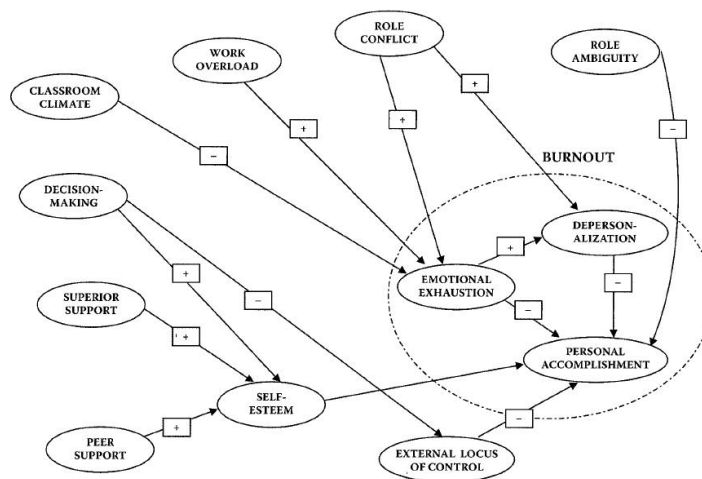


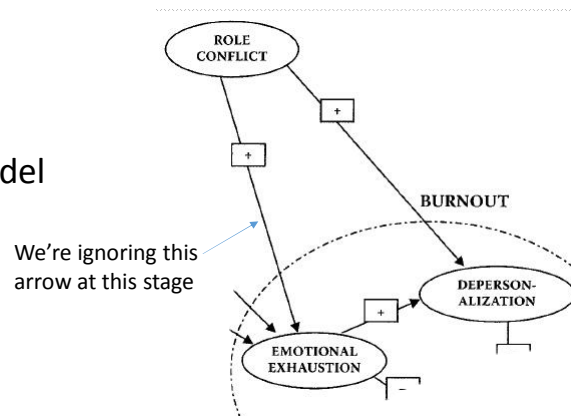
Figure 6.1. Proposed structural model of teacher burnout.

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Structural Equation Modeling With Mplus

Multiple regression 2

Part of Byrne's model of teacher burnout



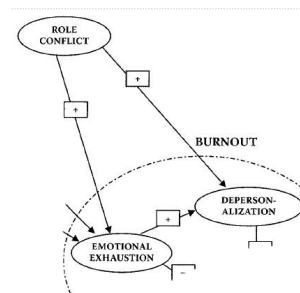
Structural equation: $\text{depersonalisation} = B_0 + B_1 \cdot \text{role conflict} + B_2 \cdot \text{emotional exhaustion} + \text{error/residual}$

Multiple regression 3

Part of Byrne's model of teacher burnout:

regressing depersonalisation ON (Y ON X) emotional exhaustion and role conflict in SPSS

*regression vars=deperson conflict exhaust/
dep=deperson/
method=enter.*



Multiple regression 4

Part of Byrne's model of teacher burnout: regressing depersonalisation ON (Y ON X) emotional exhaustion and role conflict in SPSS - output

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	375.808	2	187.904	232.205	.000 ^b
	Residual	1154.751	1427	.809		
	Total	1530.559	1429			

a. Dependent Variable: deperson

b. Predictors: (Constant), exhaust, conflict

Error/residual

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.497	.085		5.846	.000
	conflict	.158	.026	.156	5.969	.000
	exhaust	.350	.023	.402	15.368	.000

a. Dependent Variable: deperson

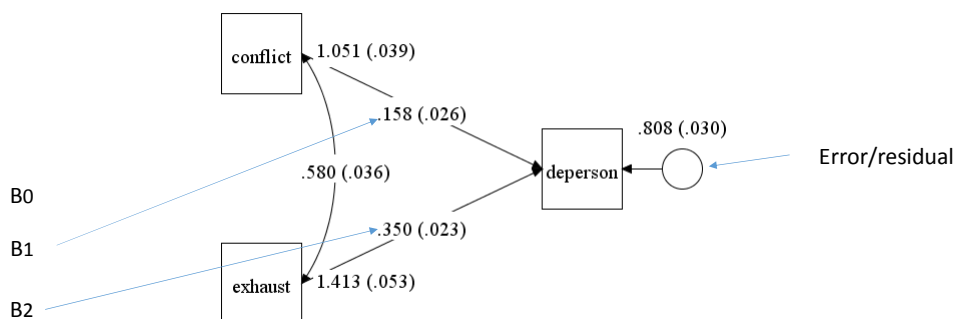
B0

B1

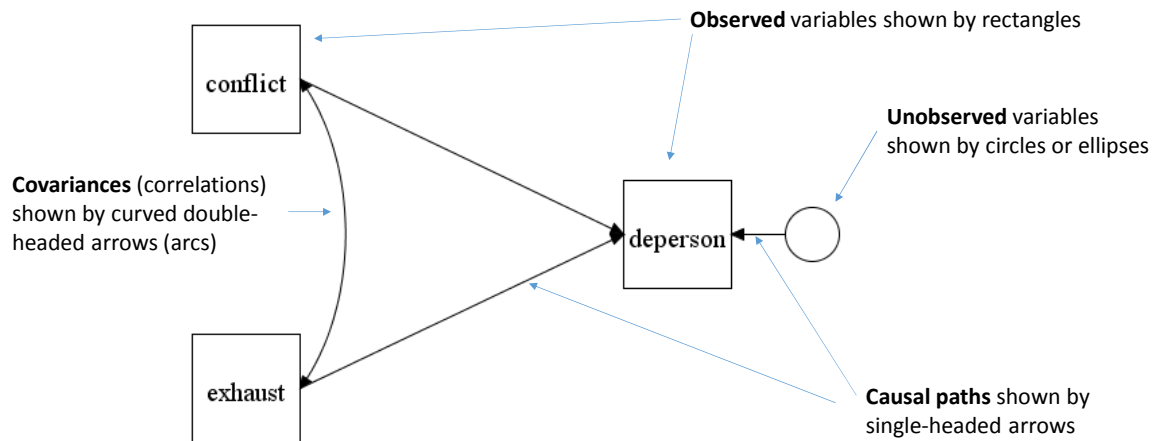
B2

Multiple regression 5

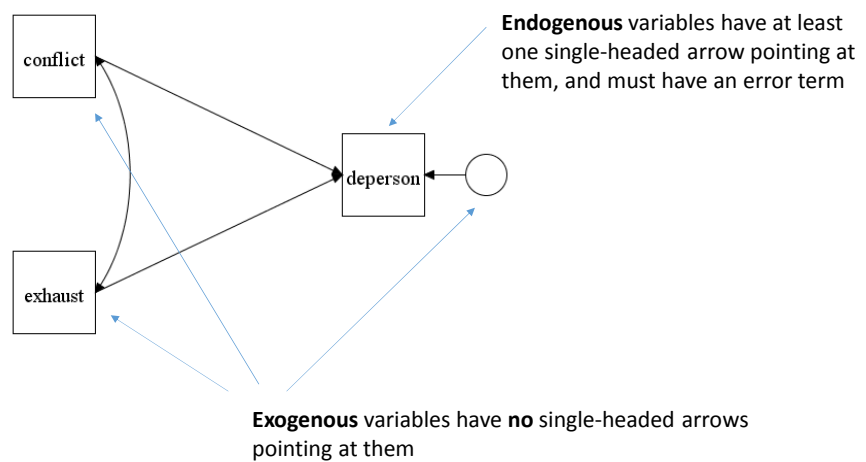
Part of Byrne's model of teacher burnout: regressing depersonalisation ON (Y ON X) emotional exhaustion and role conflict – model and results shown in path diagram



Conventions of path diagrams 1



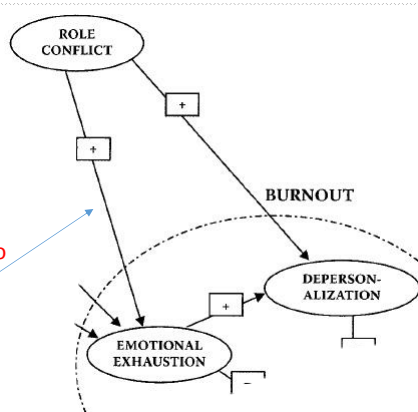
Conventions of path diagrams 2



Path analysis

Part of Byrne's model of teacher burnout

We're now going to include this path in the model

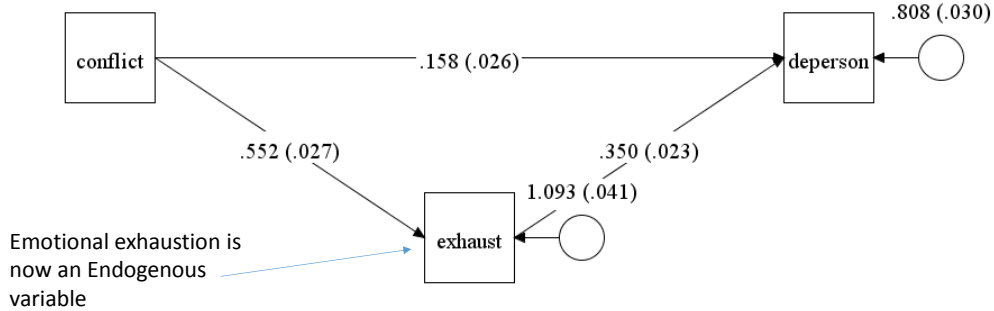
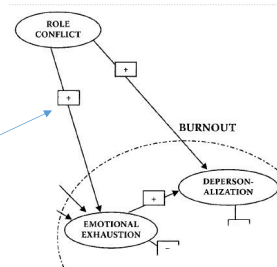


Structural equations: (1) depersonalisation = B_1 *role conflict + B_2 *emotional exhaustion + error/residual
 (2) emotional exhaustion = B_3 *role conflict + error/residual

Path analysis

Part of Byrne's model of teacher burnout

We're now going to include this path in the model



Factor or latent variable model

In the previous analyses, emotional exhaustion was represented by an observed variable, *exhaust*, which was created by taking the mean of three variables, *ee1*, *ee2* and *ee3*. Although some measurement error was averaged out by this process, a potentially superior strategy available in SEM is to use the observed variables as *indicators* of an unobserved *factor* or *latent variable*.

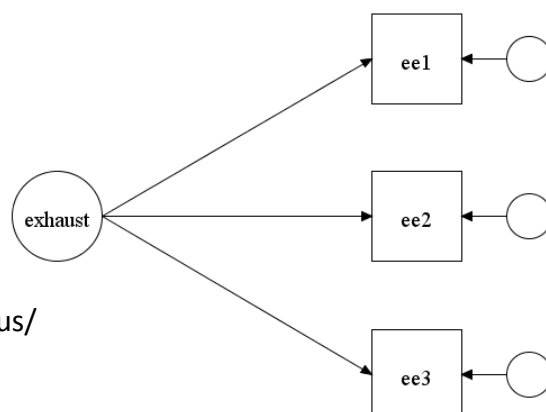
The underlying idea is that correlations among the observed variables are accounted for their relationship with the latent variable.

Factor or latent variable model

The latent variable of emotional exhaustion with its indicators.

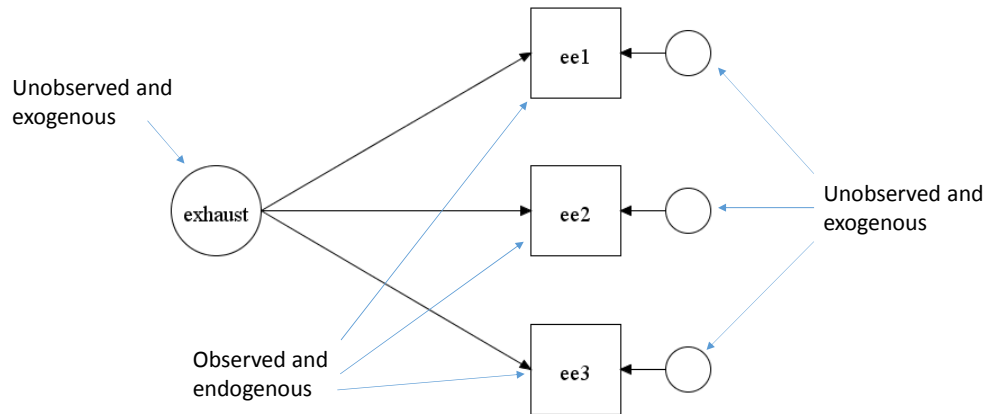
As a quick test, say whether each variable in the diagram is observed/unobserved/exogenous/endogenous.

Answers on the next slide.



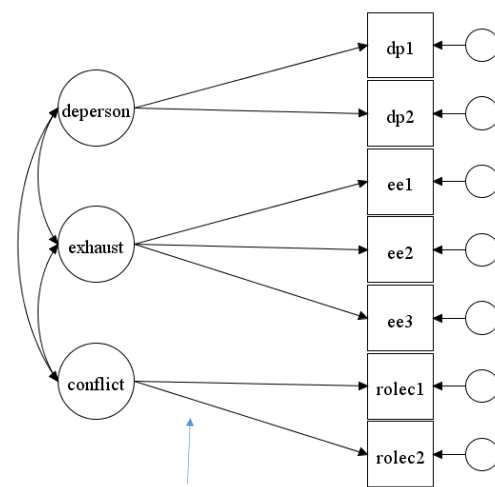
Factor or latent variable model

The latent variable of emotional exhaustion with its indicators.

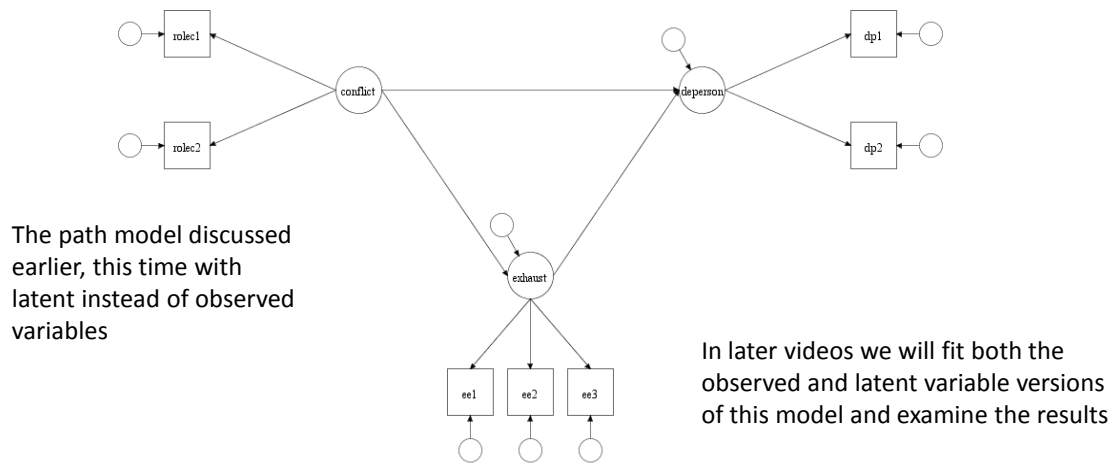


Full structural equation model

By this is usually meant a model which shows structural relationships (i.e., paths) between latent variables. A model like the one shown on right, which has only covariances and no paths between the latent variables, on the other hand, would generally be called a *measurement* model rather than a structural model.



Full structural equation model 2



Goodness of fit

All models that we fit start off as a variance-covariance matrix which shows the associations (correlations) between the observed variables. For example, here is an observed variance-covariance matrix:

Covariances	DP1	DP2	EE1	EE2	EE3	ROLEC1	ROLEC2
DP1	1.515						
DP2	-0.364	0.817					
EE1	0.560	-0.468	1.592				
EE2	0.654	-0.527	1.306	1.729			
EE3	0.904	-0.380	0.588	0.690	1.239		
ROLEC1	0.366	-0.323	0.624	0.763	0.401	1.489	
ROLEC2	0.344	-0.261	0.728	0.835	0.309	0.838	1.398

Covariances are correlations which haven't been standardised by the standard deviations of the different variables. Therefore the sizes of the covariances reflect the variability of the variables as well as the strength of their association.

Goodness of fit 2

After *Mplus* (or any other SEM software) applies the specified model to data, it then attempts to reproduce the observed variance-covariance matrix from the quantities it has estimated (or which it has been given as fixed values).

Goodness of fit indices show the extent to which the reproduced variance-covariance matrix is the same as the observed variance-covariance matrix.

The chi-squared GOF test is a commonly-used index – the higher the value of the chi-squared statistic, the greater the discrepancy between reproduced and observed matrices.

Unfortunately, the chi-squared test is also affected by sample size – larger samples give rise to larger values of chi-squared, regardless of fit. Other indices have been developed in an attempt to overcome this problem.

Covariance structures and mean structures

Often we are interested only in the associations (correlations/covariances and causal paths) between the variables in the models we fit. Note that the intercepts shown in our structural models conveniently disappeared in the path diagrams (although *Mplus* does estimate the intercepts as a default).

Sometimes, however, we are interested in estimating and/or comparing the means of the latent variables in models. In that case means become central to the structure which is being tested, and are referred to explicitly in the model specification. For examples, see Byrne, Chapter 8. In a later video, on growth curve models, we will also refer to means and intercepts, but in most of the examples covered in the videos, we will concentrate on covariance structures.

Further information

The web page <http://psy.mq.edu.au/psystat/recordings.html>

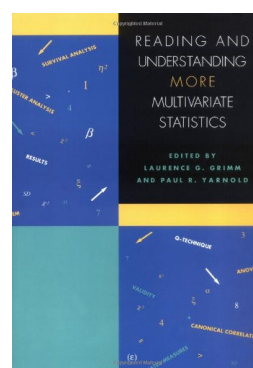
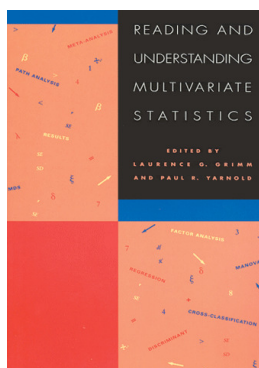


contains the following links:

- [Amos and SEM ... Download for iPad ... Associated handout](#)

The video is an introduction to SEM using AMOS. The associated handout covers the same topics as this video and also some other issues in SEM such as calculating degrees of freedom, identification, recursive and non-recursive models, and sample size.

Further information 2



Laurence Grimm & Paul Yarnold - Have useful chapters on path analysis and SEM

The next video provides an introduction to the specifics
of using

Mplus